Remarks/Arguments

Claims 52-96 are pending in the Application.

Claims 52-96 stand rejected.

Claims 72 and 86 are amended herein

I. EXAMINER INTERVIEW

On January 27, 2005, the undersigned counsel for Applicant and Dr. Ken Smith, a co-inventor of the Application, met with the Examiner to discuss the Application and the Final Office Action. Applicant and its counsel appreciate the opportunity to have this discussion and wish to thank the Examiner for the interview.

II. AMENDMENTS TO THE CLAIMS

Applicant has amended independent Claims 72 and 86 to clarify that the covalent bonding of the substituents to the single wall carbon nanotube occurs on the sidewall. No new matter is added by these amendments.

III. REJECTIONS UNDER 35 U.S.C. §§ 102(a) AND 103(a) OVER *CHEN*

In the Final Office Action, the Examiner has maintained the rejection of Claims 52-96 under 35 U.S.C. § 102(a) as being anticipated by Chen *et al.*, "Chemical attachment of organic functional groups to single walled carbon nanotube material," *Journal of Materials Research*, Vol. 13, No. 9, Sept. 1998, pp. 2423-2431 ("*Chen*"). Final Office Action, at 2. In the alternative, the Examiner has maintained the rejection of Claims 52-96 under 35 U.S.C. § 103(a) as obvious over *Chen*. Final Office Action, at 2.

Applicant respectfully traverses these rejections, including for the same reasons as expressed in its response to Amendment Under 37 C.F.R. §1.111, filed August 20, 2004 (the "1.111 Amendment"), at 2-6.

A. Rejection Under § 102

Again, Applicant repeats its response expressed in pages 2-4 of its 1.111 Amendment. In the 1.111 Amendment, the Applicant presented various citations in *Chen* to illustrate that, although *Chen* had hoped to functionalize the SWNT, *Chen* repeatedly admitted no certainty in

actually accomplishing that result. 1.111 Amendment, at 2-4. Applicant pointed out specifically why *Chen* was not in possession of sidewall functionalizd single wall carbon nanotubes. *Id.*

In the Final Office Action, the Examiner noted he considered the arguments raised by Applicant but deemed them to be non-persuasive. Final Office Action, at 2. During the Examiner Interview, the Examiner drew Applicant's attention to a statement made on page 2427, namely:

> The spectra show that dichlorocarbene moieties become attached to the SWNT's but not to the catalyst nanoparticles.

The Examiner indicated that he relied upon that statement to support his position that *Chen* discloses (or at least suggests) covalent sidewall derivatization of the single wall carbon nanotubes. Applicant respectfully submits that a review of the context of this sentence reflects a contrary interpretation. It is required that this sentence be read in its context within the *Chen* paper and that this sentence is not merely read in isolation. *See* M.P.E.P. §2141.02 (requiring that the entire reference, not just selected portions, must be considered when making a prior art rejection).

1. The Context of The Sentence Must Be Made In View of *Chen's* EDS/XPS Analyses

The above-quoted statement from *Chen* taken literally states the dichlorocarbene moieties are ***attached*** to the single wall carbon nanotube, but does not state how or where these are attached. The authors in *Chen* made this statement in view of their interpretation of the EDS/XPS results.

As reflected repeatedly in *Chen,* the ***single wall carbon nanotube material*** was a product that contained some single wall carbon nanotubes, but also contained substantial amounts of amorphous carbon. *Chen* notes amorphous carbon on the walls of the single wall carbon nanotubes in high resolution transmission electron microscopy. See *Chen*, at 2429, col. 1, Section H. Referring to Figs. 8(a) and 8(b), before and after reaction with dichlorocarbene, "The amorphous carbon coating on the walls of the SWNT's is obvious in both cases."

Chen did high resolution Energy Dispersive X-ray Spectroscopy (EDS), a technique to determine the elemental composition, but not bonding characteristics, of materials with an atomic number greater than boron imaged in a electron microscope. As indicated on page 2431 of *Chen*, the EDS spectra, shown in Figures 5(a) and 5(b), were taken with an electron microscope beam

focused to approximately 10 nm diameter. Figure 8(b) indicates illustrates the amorphous carbon overcoating the single wall carbon nanotubes. *See* Chen, col. 1, par. 1, p. 2429. From this perspective, it is likely that any 10 nm-diameter electron beam would intercept both nanotubes and amorphous carbon. The EDS evidence indicates that chlorine was present in the carbon nanotube material treated with dichlorocarbene, however, the technique does not disclose if, or to what, the chlorine is bonded.

Chen also analyzed the samples by X-Ray Electron Spectroscopy (XPS) which is a surface sensitive method with a typical information depth of 1 - 5 nm. *Chen's* XPS analysis of the pristine SWNTM is disclosed in Chen p. 2426, col 2.

> "The carbon C(1) XPS spectrum of the pristine SWNTM shows a peak at 285 eV for the sp^2 hybridized carbon atoms [Fig. 4(a), narrow peak]. This value is comparable to the C(1s) BE [Binding Energy] in graphite (284.5 eV). After reaction with dicholorocarbene [sic], a new strong peak appears in the XPS spectrum of carbon at higher BE [287.5 eV, Fig. 4(b), broad peak]. This BE is typical for C(1s) ionization of sp^3 carbon in organic chlorocarbons."

The amorphous carbon in the sample provides many sites for easy sp^3 hybridization that would be expected to react much more readily than the sp^2-hybridized carbon on the nanotube sidewalls. It is therefore more likely that the sp^3 signal that *Chen* observed in XPS was due to reaction with the more-reactive amorphous carbon or non-sidewall nanotube carbon where sp^3 hybridization would have been more probable and more energetically favorable.

This conclusion, that the dichlorocarbene was more likely attached to the amorphous carbon or non-sidewall nanotube carbon finds further support in *Chen.* The sidewall surface of single wall carbon nanotubes is graphite-like in structure, and *Chen* carried out a control experiment using graphite under the same reaction conditions, but saw no chlorine peaks using EDS analysis. See *Chen*, at 2427, col. 2. Thus, since the surface of graphite was unreactive with dichlorocarbene, it would be similarly quite unlikely that the single wall carbon nanotubes of *Chen* were derivatized on their sidewalls.

Thus, *Chen* provides no convincing evidence that the dichlorocarbene moiety was ever attached to the sidewalls of single wall carbon nanotubes.

2. This Interpretation Of The Sentence Is Consistent With The Rest of *Chen*

Such an interpretation of the sentence is in complete accord with the authors conclusions, namely:

> In conclusion, our results are consistent with the addition of chemical functionalities to the surface of the SWNT bundles, but ***we cannot distinguish between attachment to the walls of the SWNT's and attachment to the amorphous carbon that is present on the walls in current samples***.

(*Chen*, Col. 1, par. 7, at 2429 (emphasis added)).

Similarly, the authors of *Chen* stated in the Abstract:

> All of the reactions provide evidence for the chemical attachment to the SWNTM's, [single wall carbon nanotube material] but because of the impure nature of the staring [*sic*, starting] materials, we are unable to ascertain the site of reaction. In the case of dichlorocarbene, we are able to show the presence of chlorine in the SWNT bundles, ***but as a result of the large amount of amorphous carbon that is attached to the tube walls, we cannot distinguish between the attachment of dichlorocarbene to the walls of the SWNT's and reaction with the amorphous carbon***.

(*Chen*, in Abstract, at 2423 (emphasis added)).

Thus, a review of *Chen* reflects:

A) There is nothing in the above quoted sentence or elsewhere in *Chen* supporting the attachment of the dichlorocarbene moieties was to the single wall carbon nanotubes rather than only the amorphous carbon coating the single wall carbon nanotubes.

B) Assuming, for the sake of argument, there was some attachment directly to the single wall carbon nanotube (notwithstanding statements by the authors in *Chen* that they had no evidence this has occurred), there is nothing to support in the sentence or elsewhere in *Chen* supporting that such attachment was to the ***sidewalls*** of the single wall carbon nanotubes (rather than only the ends of the single wall carbon nanotubes, which are known to be much more reactive than the sidewalls).

C) Assuming, for the sake of argument, there was some attachment directly to the sidewalls of the single wall carbon nanotubes (again, notwithstanding statements by the authors in *Chen* that they had no evidence this has occurred) there is nothing in the sentence of elsewhere in *Chen* supporting that such attachment was covalent bonding of the moiety to the carbon atoms on the sidewall of the single wall carbon nanotube.

Accordingly, the statement by the authors, who selected the term "attached" to the single wall carbon nanotubes in the sentence relied upon by Examiner, cannot somehow be transmuted to mean the authors of *Chen* had covalently bonded the moiety to the carbon atoms on the sidewall of the single wall carbon nanotubes. As noted previously, such an interpretation of the

sentence under discussion must be wrong, as it is completely inopposite to the expressed conclusions of the authors of *Chen*.

3. *Chen* Does Not Enable The Claimed Invention

Each of the independent claims of the Application, require covalently bonding of the substituent to the sidewall of the single wall carbon nanotubes. *See,* Application, Claims 1, 62, 72, and 86. Thus, all claims require the covalent bonding of the substituent to the sidewall of the single wall carbon nanotubes.

The Federal Circuit has held "[e]nablement requires that 'the prior art reference must teach one of ordinary skill in the art to make or carry out the claimed invention without undue experimentation.'" *Elan Pharmaceuticals Inc. v. Mayo Foundation for Medical Education and Research,* 346 F.3d 1051, 68 U.S.P.Q.2d 1373, 1376 (Fed. Cir. 2003) (quoting *Minnesota Mining and Manufacturing Co. v. Chemque, Inc.*, 303 F.3d 1294, 1301, 64 U.S.P.Q.2d 1270, 1278 (Fed. Cir. 2002)); *see also Enzo Biochem, Inc. v. Calgene, Inc.*, 188 F.3d 1362, 1369, 52 U.S.P.Q.2d 1129, 1134 (Fed. Cir. 1999). As noted above, there is absolutely no evidence that *Chen* covalently bonded substituents to the sidewall of single wall carbon nanotubes. The authors repeatedly conceded that, despite their best efforts to prove so, they could not show that this had occurred. *See* 1.111 Amendment, at 2-4. It is axiomatic that if the authors' experimentation was unable to show that this had occurred, *Chen* did not teach one of ordinary skill in the art to make or carry out the invention without undue experimentation. Thus, *Chen* is not an enabling reference.

4. *Chen* Does Not Inherently Disclose The Invention

To overcome this gap, the Examiner states that "[t]he reference [*Chen*] gives a reasonable expectation that the claims are possessed, particularly since the claims only require 'one' substituent group attached." Final Office Action, at 2. Applicant traverses this statement as there is no reasonable expectation as suggested by Examiner. Moreover, Applicant traverses this statement in that "reasonable expectation" is not the proper standard. Examiner's position is that while *Chen* does not disclose the covalent bonding of substituent to the sidewall of single wall carbon nanotubes, such covalent bonding is ***inherently*** happening at least to some degree. Final Office Action, at 2. For inherency to be shown, extrinsic evidence must be presented that makes "clear that the missing descriptive matter is ***necessarily*** present in the thing described in the

reference, and that it would be so recognized by persons of ordinary skill." *Continental Can Co. v. Monsanto Co.*, 948 F.2d 1264, 1268, 20 U.S.P.Q.2d 1746, 1749 (Fed. Cir. 1991) (emphasis added). Inherency cannot be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is legally insufficient. *Id.*, 948 F.2d at 1269, 20 U.S.P.Q.2d at 1749. Thus, the Examiner's "reasonable expectation" is an insufficient basis for the Examiner to rely upon to show that *Chen* disclosed (or suggested) the claimed invention. Applicant notes that even the authors of *Chen*, despite their efforts and specific testing, were unable to show that their experiments yielded single wall carbon nanotubes with substituents covalently bonded on the sidewall. Given *Chen* expressly indicates the authors' inability to show this, this element cannot be inherently disclosed in *Chen*.

The Examiner appears to rely upon non-prior art United States Patent No. 6,331,262 issued to Haddon *et al.* ("*Haddon*") in support of the "reasonable expectation" arguments. A review of *Haddon* does not reveal any statement that covalent bonding of substituents on the sidewalls of the single wall carbon nanotubes was occurring. Rather, *Haddon* reflects a reference to the *Chen* paper and later on states that "[s]uch solutions [of *Haddon*] are ***anticipated*** to be useful in determining the functionalization chemistry of the open ends, the exterior walls or convex face and the interior cavity or concave face of single walled carbon nanotubes ...." *Haddon*, Cover Page, Other Publications & col. 1, *ll.* 55-62 (emphasis added). Thus, as in *Chen,*[1] *Haddon* does not reveal a covalent-bonding of substituents on the sidewall of single wall carbon nanotubes. Applicant notes that *Haddon,* does not claim sidewall derivatized single wall carbon nanotubes. Applicant surmises, if the inventors of *Haddon* had thought they were in possession of sidewall derivatized single wall carbon nanotubes, the claims in *Haddon* would have been directed to such an invention.

In short, *Haddon* does not support the Examiner's statement that there is a "reasonable expectation" that substituents are covalently bonding to the sidewalls of the single wall carbon nanotubes.

[1] The named inventors of *Haddon* are two of the co-authors of *Chen.*

5. Other Evidence Supports *Chen* is not Enabling

Applicant again notes that Holzinger *et al.*, Angew. *Chem. Int. Ed.*, **2001**, *40*, 4002-4005 ("*Holzinger*," which is attached as Exhibit A to Applicant's 1.111 Amendment) affirms Applicant's position that *Chen* was not in the possession of sidewall functionalized/derivatized single wall carbon nanotubes. 1.111 Amendment, at 4. In *Holzinger*, Hirsch and co-workers point out that "direct chemical functionalization of the [carbon nanotube] sidewalls using addition reactions, of which direct fluorination and subsequent nucleophilic substitution, and the addition of aryl radicals formed by the reduction of aryl diazonium salts are the only procedures reported to date." (*Holzinger*, p. 4002, col. 1) The direct fluorination and subsequent nucleophilic substitution to which *Holzinger* refers is Applicant's own work, and the addition of aryl free radicals to which *Holzinger* refers is the subject of commonly-assigned International Patent Application No. WO 02/060812 having a priority date *after* the presently claimed invention.

Further evidence in support of Applicant's position is the attached Declaration of Dr. Richard Smalley Under 37 C.F.R. § 1.132. Dr Smalley is a co-inventor of the present Application and is also one of the co-authors of *Chen*.

In view of the above, Applicant respectfully submits that there is no basis for claiming *Chen* disclosed or suggested, inherently or otherwise, the invention of the pending claims of the invention.

6. Degree of Functionalization for Certain Dependant Claims.

Certain of the pending claims of the Application are directed to the amount of substituent bonded to the carbon atoms of the sidewall of the single wall carbon nanotubes. Such claims include Claims 59-61, 69-71, 79-81, and 94-96. In the Final Office Action, the Examiner indicated he desired Applicant to repeat the experiments of *Chen* to determine the number of attached groups. Putting aside for a moment that *Chen* does not disclose any groups bonded to carbon atoms on the sidewalls of the single wall carbon nanotubes, *Chen* reveals the samples showed about 5% chlorine in the single wall carbon nanotube materials. *Chen*, col 2, par. 5, at 2425. From this number, the molar ratio of moiety or substituent per mole of carbon can be calculated. The 5% chlorine of *Chen* is assumed to be a on a weight basis, per normal quantitative analysis. In terms of dichlorocarbene, the sample would be 5.8 wt%

dichlorocarbene. (5 wt% x 83 g/mole dichlorocarbene/ 71 g/mole Cl in dichlorocarbene). If 5.8 grams of dichlorocarbene moiety were present in 100 grams of moiety-derivatized nanotube, disregarding all amorphous carbon, then the molar ratio would be 0.07 moles dichlorocarbene to 7.85 moles carbon, or approximately 1 substituent to 112 carbon atoms, which is well outside the ratio ranges expressed in Claims 59-61, 69-71, 79-81, and 94-96.

Accordingly, there is no disclosure or suggestion in *Chen* directed to the degree of functionality expressed in dependent Claims 59-61, 69-71, 79-81, and 94-96.

Therefore, as a result of the foregoing, Applicant respectfully requests that the Examiner withdraw his rejection of Claims 52-96 under 35 U.S.C. § 102(a) as being anticipated by *Chen*.

B. Rejections Under § 103

Regarding the rejections of Claims 52-96 under 35 U.S.C. § 103(a) as being obvious over *Chen*, Applicant again asserts the arguments raised in its 1.111 amendment, at 4-6, and also its arguments stated above. Among these things, these reveal:

There is no suggestion or motivation to modify the teachings of *Chen* to arrive at the presently claimed invention.

There is no reasonable expectation of success, were there a suggestion or motivation to modify the processes of *Chen*, that the derivatized single wall carbon nanotubes of the presently claimed invention could be produced

Chen fails to teach all the claimed limitations of each of Claims 52-96.

As discussed above, *Chen* does not produce sidewall derivatized single wall carbon nanotubes, and it is acknowledged in the art that the Applicant of the present invention was the first to derivatize the sidewalls of single wall carbon nanotubes (*Holzinger*) and, that as late as 2001, carbene reactions were not considered a viable method for sidewall derivatization of single wall carbon nanotubes.

Accordingly, Applicant respectfully requests the Examiner withdraw the rejection of Claims 52-96 under 35 U.S.C. § 103(a) as being unpatentable over *Chen*.

IV. CONCLUSION

As a result of the foregoing, it is asserted by Applicant that the remaining Claims in the Application are in condition for allowance, and respectfully request allowance of such Claims.

Applicant respectfully requests that the Examiner call Applicant's attorney at the below listed number if the Examiner believes that such a discussion would be helpful in resolving any remaining problems.

RESPECTFULLY SUBMITTED,

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